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KETTLES IN GLACIAL LAKE DELTAS.¹

THE object of this brief paper is to describe a remarkable basin in a glacial-lake delta in western New York, and to discuss similar phenomena in general only so far as to throw light upon this particular case.

Between Canandaigua and Seneca valleys lie three north and south valleys which hold no lakes. The most westerly of these is the Middlesex or West River Valley, which drains south into the head of Canandaigua Lake. The next is the valley of Flint Creek, which flows north. Eastward is another deep valley which drains south into Keuka Lake, at Branchport. Upon the west side of the middle one of these three lakeless valleys, the Flint Creek Valley, lies the little village of Potter. Close behind the village is a conspicuous plateau of stony gravel rising 250 feet above the valley plain. In the middle of this ancient plain occurs the singular basin herein described.

This delta is one of the many phenomena which record the intricate and interesting history of the glacial waters in the "Finger Lake" region. The events leading up to its formation seem to be as follows: During the recession of the front of the ice-sheet there came a time when the southern or upper end of each north-sloping valley was free of ice, and the impounded waters were forced into southward flow.²

In the Keuka Valley the glacial waters were at first compelled to overflow directly south into the Cohocton River at Bath, but they soon found a somewhat lower outlet across the eastern rim of the basin through the site of Wayne village and the chain of small lakes. These waters have been named the

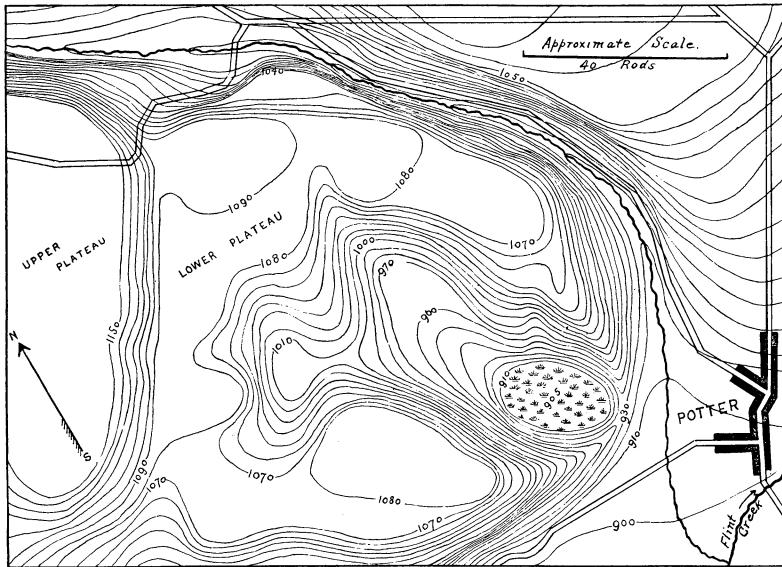
¹ Presented before the American Association for the Advancement of Science, August 25, 1898.

² Papers descriptive of the glacial lakes of western-central New York may be found in the Bulletin of the Geological Society of America, Vol. VI, pp. 353-374; Vol. VII, pp. 449-452; Vol. VIII, pp. 269-284.

Hammondsport Lake. Probably somewhat later the southern end of the Canandaigua Valley was occupied by glacial waters, the Naples Lake, which have left a well defined overflow channel near Atlanta. At this level the Naples Lake flooded as much of the Honeoye Valley upon the west, and the West River or Middlesex Valley upon the east, as the recession of the ice-sheet had left open. With further removal of the ice-front a lower outlet for the Naples Lake was uncovered on the eastern border of the Middlesex Valley, about two miles northeast of Middlesex village, and a channel was cut by the escaping waters leading east toward Potter. It was the stream which cut this channel, and drained the waters of the Canandaigua-Middlesex valleys into the Hammondsport Lake, that built the Potter Delta. The ravine is about one mile long. Its depth will average about 100 feet, mostly in shale, with a width at the bottom of about 100 feet, and a uniform gentle grade, with a total fall of about 30 feet. At present it carries no stream. The lower end of this channel is not far above the level of the valley plain of Flint Creek, which indicates that the channel was effective even after the glacial waters in the Flint Creek Valley had found an outlet not far higher than the present plain. Indeed, the gravel and sand plain of the broad valley bottom is probably the filling during the last phase of the glacial waters. The delta represents the earlier deposits at the mouth of the down-cutting stream in the higher or Hammondsport Lake. There are two prominent levels on the delta. Aneroid measurements, using the Lehigh Valley Railroad at Middlesex and Rushville as datum, make the altitude of the valley plain at Potter about 900 feet. The lower and broader delta plateau is about 1080 feet, and the higher, summit plateau about 1150 feet. This higher level corresponds with the summit levels of the several old deltas in the Keuka Valley proper. The lower level represents some stage of the Flint Creek Valley waters not positively correlated at the time of this writing. As the waters fell in the Flint Creek Valley, the ancient stream, continually cutting down to the local base level, bisected and eroded the earlier delta deposits.

While not so extensive as some deposits of similar origin, this delta is a comparatively large one for the ephemeral glacial lakes of the region. By estimate it is about one-third of a mile across.

The form and topography of the delta and the included basin are fairly shown in the accompanying sketch. The dis-



Kettle in Delta at Potter, N. Y.

tances are by eye-estimate and the elevations by aneroid. While the absolute elevations are not exact, the relative heights are approximately accurate. The sketch does not show the rock cut nor the continuation of the two terrace levels along the ravine upon the north side, these being perhaps one-eighth of a mile north of the area shown in the map. The higher level is there a filling of an angle or recess in the hills, about 40 rods wide and with a bar or ridge on the front. The lower level is represented by a rock terrace about 10 rods wide. Behind the higher plateau, on both sides of the ravine, the ground is lower, with ridges and hollows transverse to the stream direction.

The materials composing the delta are quite variable and poorly assorted, containing an unusual amount of large stones and even boulders. This is especially the case on the northeast side of the 1080 feet plateau, where several heavy stone fences have utilized only a portion of the field stone. These, however, might be wholly attributed to the powerful stream, but many larger and angular boulders on the slopes of the basin are not so explained.

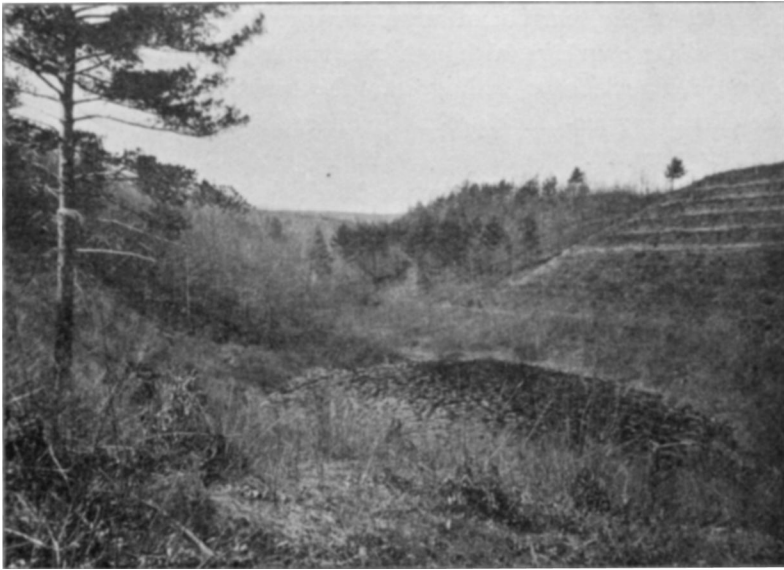
Of the origin of the kettle two hypotheses have been considered; one, that it was a result of capricious currents and deficient filling, the other that the basin is a portion of the space occupied by a block of ice during the deposition of the delta. The first explanation was suggested by the form of the spitlike, sloping ridges on either side of the swamp, the location of the deepest part of the basin at the extreme edge of the delta, and by the existence, in other deltas, of smaller kettles apparently produced by the aqueous forces alone. This explanation is now thought inadequate for the Potter basin.

During the study of this feature correspondence was held with Professor J. B. Woodworth, from whom valuable suggestions have been received. The sketch and photographs were sent to him, and he thought the Potter phenomena similar to other basins which he had studied in New England, and the genesis of which is confidently referred to ice-blocks. The writer accepts this theory for the origin of the Potter basin.

The deepest part of the basin is an oval swamp which holds water until removed, apparently, by evaporation. This indicates an impervious bottom. The depth of the vegetal accumulation is undetermined, but it seems probable that the original bottom of the kettle must have been in till or on rock, and below the water-laid drift. It seems improbable that such a deep hole, with walls so steep, could have been produced as a constructional feature in open water. If such were the case, the spitlike points inclosing the kettle should consist of the finest material brought down by the dying currents. The material, on the contrary, is not sand or even fine gravel, but stony gravel, and the

material of the low ridge at the notch opening into the basin is more like till than it is like gravel. Water movement probably had some part in the formation of the ridges, the currents sweeping about the half buried ice-block.

If the basin were due to deficient filling obviously the inner slopes should consist of finer material dropped by the weakened



Kettle in Delta at Potter, N. Y. View of deepest part looking north.

currents. Such is not the case. The materials are stony, and even large boulders occur. The writer observed no boulders which might not possibly have been rolled by powerful currents, although the much more reasonable explanation would attribute them to ice transportation. The owner of the larger part of the basin said that blocks of stone exist in the basin "as large as a team could haul."

The existence of elevated portions or isolated areas somewhat above the general plateau level might be regarded as due to erosion of the surrounding area, but seem more reasonably

due to contributory deposition by ice, especially as they are quite stony.

The ice-block was probably not entirely buried but projected above the surface of the delta, otherwise the deep swamp kettle would have been partially filled with the water-laid delta material falling in upon the melting ice. The notch at the edge of the kettle is apparently a constructional form, and there is no evidence of any current of water having flowed through it. It is still a narrow ridge, although somewhat flattened or lowered by use for a roadway leading into the basin. The water from the dissolving ice-block probably filtered out through the surrounding gravel.

A natural objection to the ice-block theory is the existence of such an isolated mass of ice for a great length of time. The relations of the stream and delta with the water bodies require the ice-front to be removed some uncertain distance to the northward. This objection, however, has not been given great weight by the students of similar phenomena.

This basin is by far the largest one that the writer has seen in the lacustrine deposits of western-central New York. However, it is not the only one suggesting ice-block genesis. Other deep steep-sided kettles have been seen in the deltas, especially on the slopes of Seneca and Keuka valleys, which may most reasonably be attributed to such origin. The writer has particularly in mind one a short distance above the Hector station, on the east side of Seneca Lake. This seems to lie above the plane of glacial waters and was apparently formed in the exposed delta.

In many deltas, small basins, or hollows, or bowls, occur which have been attributed to aqueous forces alone. These are usually located behind embankments or bars lying transverse to the stream, and vary in form from hollows open at one end to well enclosed kettles. So far as noted, although close study has not been made, the walls are of clear sand or gravel, the depths not great as compared with the breadth, and the forms are simple curves. Their origin seems explained by conflict of waves and

shore currents with the detritus-bearing stream currents. On the lakeward side they are usually bounded by a spit or bar formed transverse to the stream current. Some of the larger and more irregular depressions are bounded landward by the original surface of the valley border, but such are more likely to be open on the side away from the delta-forming stream.



Kettle in Delta at Potter, N. Y. General view, looking northwest from opposite side of Flint Creek Valley.

Those which are confidently referred to aqueous forces occur below the water plane, or are surely subaqueous.

Professor Chamberlin in discussing "kettles," in 1877, suggested four possible methods of origin: (1) Irregularities of deposition or heaping of the drift; (2) the pushing of one drift ridge unconformably against a preceding one; (3) the incorporation of ice-blocks; and (4) under-drainage. To this enumeration the writer would add a fifth method, (5) circum-deposition, by capricious stream currents in the face of wave action, or deficient filling on delta terraces.

The basins which occur in broad stream deposits, and which have suggested the name "pitted plains" have been confessedly difficult of explanation. The notable ones near New Haven have been thought to be due to deficient filling, or to whirling currents in the river. Professor Woodward informs the writer that he is convinced, from his personal examination, that these are of ice-block genesis. Such basins have not been often observed in New York. The best example that has fallen under the writer's observation lies near the village of Tully, upon the south, in the gravel plain left by the glacial waters. It borders the highway leading from the station and village to the Assembly grounds, and is of irregular shape and large extent. The most reasonable explanation is that it was the site of an isolated mass of ice, but whether buried in the gravel or projecting above is not determined, no study of the basin having been made. The occurrence further south, in the same detrital plain, of numerous lakelets, suggests that there are probably many similar basins in the locality.

SUMMARY.

The basins in deltas seem to be divisible into two classes :

- (a) Those by ice-block origin, and
- (b) Those by circumdeposition.

These may be discriminated by the following theoretical characters :

(a) Shape usually irregular; relatively deep; walls steep; material of the walls coarse or even till-like, with possible boulders; size, often large; position, often above the water-plane. (These characters would be greatly modified in cases where the ice-block was wholly buried in the drift.)

(b) Position always beneath water-plane, and usually behind a bar or embankment; depth relatively small; shape, with smooth curving outlines; material of the walls, well assorted and finer than the adjacent delta mass.

HERMAN L. FAIRCHILD.